



PAUL G. ALLEN SCHOOL  
OF COMPUTER SCIENCE & ENGINEERING

# CSE341: Programming Languages

## Lecture 26 Course Victory Lap

Eric Mullen  
Autumn 2019

# *Final Exam*

As also indicated in class-list email:

- Next **Tuesday, 8:30-10:20AM**
- Intention is to focus primarily on material since the midterm
  - Including topics on homeworks and not on homeworks
  - May also have a little ML, just like the course has had
- You will need to write code and English, but the focus will be on code

# Victory Lap

A victory lap is an extra trip around the track

- By the exhausted victors (us) 😊

Review course goals

- Slides from Introduction and Course-Motivation

Some big themes and perspectives

- Stuff for five years from now more than for the final

Time for open Q&A

**Do your course evaluations!!!**



# *Thank you!*

- **Huge** thank-you to your TAs
  - Great team effort
  - Really invested in a successful course

# *Thank you!*

- And a huge thank you to all of **you**
  - Great attitude about a very different view of software
  - Good class attendance and questions
  - Occasionally laughed at stuff 😊
- Computer science ought to be challenging and fun!

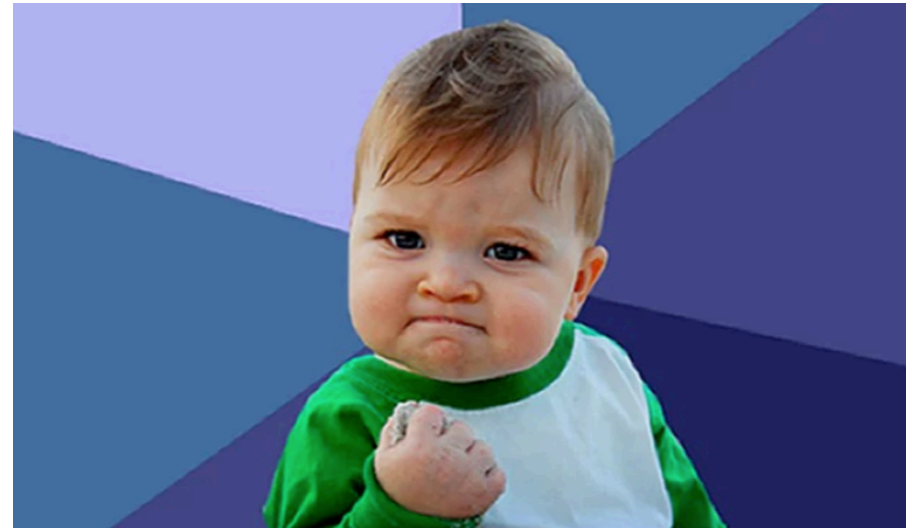
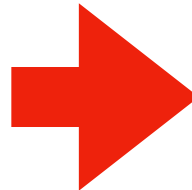
# *[From Lecture 1]*

- Many essential concepts relevant in any programming language
  - And how these pieces fit together
- Use ML, Racket, and Ruby languages:
  - They let many of the concepts “shine”
  - Using multiple languages shows how the same concept can “look different” or actually be slightly different
  - In many ways simpler than Java
- Big focus on *functional programming*
  - Not using *mutation* (assignment statements) (!)
  - Using *first-class functions* (can’t explain that yet)
  - But many other topics too

# *[From Lecture 1]*

*Learning to think about software in this “PL” way will make you a better programmer even if/when you go back to old ways*

*It will also give you the mental tools and experience you need for a lifetime of confidently picking up new languages and ideas*



## *[From Course Motivation]*

- No such thing as a “best” PL
- Fundamental concepts easier to teach in some (multiple) PLs
- A good PL is a relevant, elegant interface for writing software
  - There is no substitute for precise understanding of PL semantics
- Functional languages have been on the leading edge for decades
  - Ideas have been absorbed by the mainstream, but very slowly
  - First-class functions and avoiding mutation increasingly essential
  - Meanwhile, use the ideas to be a better C/Java/PHP hacker
- Many great alternatives to ML, Racket, and Ruby, but each was chosen for a reason and for how they complement each other



## *[From Course Motivation]*

SML, Racket, and Ruby are a useful *combination* for us

	dynamically typed	statically typed
functional	Racket	SML
object-oriented	Ruby	Java

*ML*: polymorphic types, pattern-matching, abstract types & modules

*Racket*: dynamic typing, “good” macros, minimalist syntax, eval

*Ruby*: classes but not types, very OOP, mixins

[and much more]

Really wish we had more time:

*Haskell*: laziness, purity, type classes, monads

*Prolog*: unification and backtracking

[and much more]

# *Benefits of No Mutation*

[An incomplete list]

1. Can freely alias or copy values/objects: Unit 1
2. More functions/modules are equivalent: Unit 4
3. No need to make local copies of data: Unit 5
4. Depth subtyping is sound: Unit 8

State updates are appropriate when you are modeling a phenomenon that is inherently state-based

- A fold over a collection (e.g., summing a list) is not!

# *Some other highlights*

- Function closures are *really* powerful and convenient...
  - ... and implementing them is not magic
- Datatypes and pattern-matching are really convenient...
  - ... and exactly the opposite of OOP decomposition
- Sound static typing prevents certain errors...
  - ... and is inherently approximate
- Subtyping and generics allow different kinds of code reuse...
  - ... and combine synergistically
- Modularity is really important; languages can help

# *From the syllabus*

Successful course participants will:

- Internalize an accurate understanding of what functional and object-oriented programs mean
- Develop the skills necessary to learn new programming languages quickly
- Master specific language concepts such that they can recognize them in strange guises
- Learn to evaluate the power and elegance of programming languages and their constructs
- Attain reasonable proficiency in the ML, Racket, and Ruby languages and, as a by-product, become more proficient in languages they already know

# *What now?*

- Use what you learned whenever you reason about software!
- CSE 401
- CSE 402

Does PL research (cf. [uwplse.org](http://uwplse.org)) design new general-purpose languages? *Not really; it does cool stuff with same intellectual tools!*

Some current UW projects

- 3D-printing tools
- Checker framework
- Rosette
- Language for microfluidics
- Verified software written in Coq (which is quite SML-like)

*The End*

This really is my favorite course and it probably always will be



Don't be a stranger!

*Time for ask-me-anything questions?*